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WEAR BEHAVIOR OF AL-6061 REINFORCED WITH BORAX MMCS

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ABSTRACT

The engineering fraternity has always been on the lookout for wonder-materials which would fit the bills for all types of service conditions. It stem from the need to make progressive discoveries made by scientists, affordable. This affordability quotient has persuaded many researchers to develop such materials which would satisfy various hitherto unexplored conditions. In today's world almost all generic materials have been tried for various uses and their limitations have been met. But the never ending quest of civilization requires that materials qualify for harsher environments. The area of composites with Al-6061 as the base material has led us to investigate the wear properties of the composites. In this work Al-6061 melted and mixed with Borax at various proportions using the stir casting method. The composite is tested for wear which has given promising results. There is an improvement in the wear resistance and increase in the hardness of the material that is synthesized in this research. The composite thus obtained can be used in the applications where wear resistance is required with light weight composition.

Key Words: *Aluminium 6061, Borax, Stir casting, composite.*

INTRODUCTION

MMCs can be described as a group of materials in which a continuous metallic phase (matrix) is combined with one or more reinforcement phases. The aim of such a composite material is to enhance the suitability of the end product by selectively enhancing the complimentary properties, and masking the detrimental properties of the matrix and the reinforcement. [1]. Introduction of Borax has enhanced the light weight characteristics of Aluminium composites and a self lubricating effect when used at various quantities [3]. In this research an attempt is made to add Borax particulate matter into the Al- 6061. This study is aimed at synthesis of composites and their wear characterization studies.

Aluminium is a material which is light weight and has good resistance to corrosion. Due to the low density of Al6061, it is widely used in aerospace and navy applications. In many defense applications where materials have to undergo harsh environments these alloys and composites are the best suited materials. The chemical composition of Al6061 is presented in the Table.1

Borax, also known as sodium borate, sodium tetraborate, or disodium tetraborate, is an important boron compound, a mineral, and a salt of boric acid. Powdered borax is white, consisting of soft colorless crystals that dissolve easily in water. Because of its self lubricating and structural properties, borax is added during stir casting method. Adding borax helps in increasing hardness and decreasing weight of the Al composites.

Table.1 Chemical composition of Al6061

Element	Cr	Cu	Mg	Zn	Fe	Mn	Si	Ti	Al
Percent	0.35	0.4	1.2	0.25	0.7	0.15	0.8	0.15	95.85

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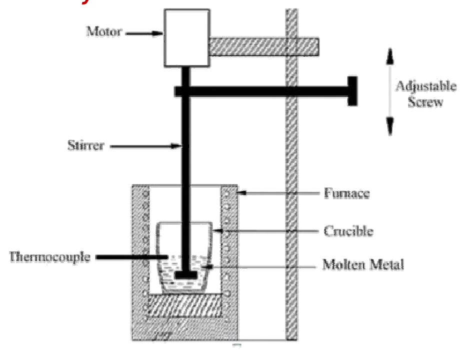


Fig.1 Stir casting apparatus

EXPERIMENTAL DETAILS

Al6061 is melted at 750˚C in the furnace and a mechanical stirrer attached to the motor mixes the reinforcement material. This method is the most commonly used method for obtaining a reasonably well distributed particulate reinforcement in the composite material. Fig.1 shows the stir casting apparatus used in the present study. Melting of Al-6061 and reinforcement of borax in the furnace the molten metal is poured into castings as per ASTM E8M standard for making specimen for testing.

1 Synthesis of Al6061 –borax composites:

The materials used in this study as a matrix material is Al-6061 whose composition, properties are given in Table 1. Reinforcement materials used for this study are Borax in the form of powder 100µm size.

The molten metal at 750˚C was added with flux to remove any atmospheric contamination. The slag consisted NaCl+NaF+KCl in definite proportions. At around 800˚C the powder Borax particles are added to the vortex of the stirrer. The stirrer speed was 300 rpm and the stirring time was 5 minutes. The metal mould was preheated and the molten metal was poured into the moulds in different wt% A,B,C,D. After the cooling process the material is removed from the mould and the die. The cast materials were further to machining where the material was made to the size as per ASTM standards as shown in Fig. 2a & 2b.

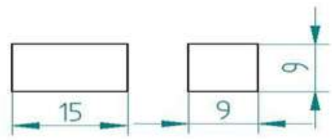
Fig. 2a As cast

Fig. 2b Machining of the specimen as per ASTM standards

Hardness Tests:

In mineralogy the property of matter commonly described as the resistance of a substance to being scratched by another substance. In metallurgy hardness defined as the ability of a material to resist plastic deformation.

The hardness specimen dimension 15mm length and 9mm square face its follows ASTM standard with the aspect ratio 1.66 (l/d ratio) is as shown fig.3



All dimensions are in mm

Fig. 3 Specimen dimension for Hardness and Microstructure test.

Wear Test

The wear test specimens are 10mm in diameter and 35mm in length from which wear test specimens are machined with 8mm diameter and 60mm length with the ASTM G95 is shown fig 3.10, initial tests are carried out in order to ascertain the range of parameters via load, speed and distance. The tribological responses are expected in terms of wear friction co -efficient and specific wear rate. [5] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

Fig. 4 Specimen dimension for Wear test as per ASTM G95 standard.

Dry sliding test are conducted with cumulative damage technique, where the specimens are subjected to wear for different loads in the range of 1,2 and 3kg. The sliding distance is kept constant and the load is increased in predetermined steps.

Few initial tests are carried out in order to ascertain the range of parameters via load, sliding speed and sliding distance with the requirement that does not occur then the tests are carried out at sliding speed of 20 m/s and sliding distance of 1000m in for each load. The tribological responses are expected in wear friction co-efficient and specific

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wear rate.

RESULTS AND DISCUSSION

Micro Structure:

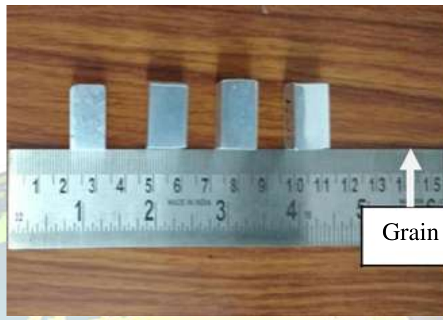

Fig -5: Microstructure Specimen

The etched specimens observed under the microscope revealed the following structure, by using OM

The etched specimens observed under the microscope revealed the following structure, by using OM (optical microscope).

Fig. 5.1 Optical Micrographs of MMC's Composition A 100-200µ (Al 6061).

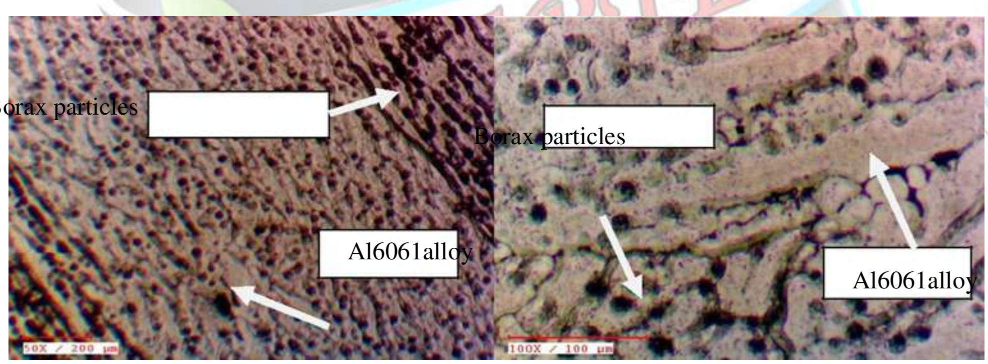

Fig. 5.2Optical Micrographs of MMC's Composition A 100-200µ (Al+2% Borax)

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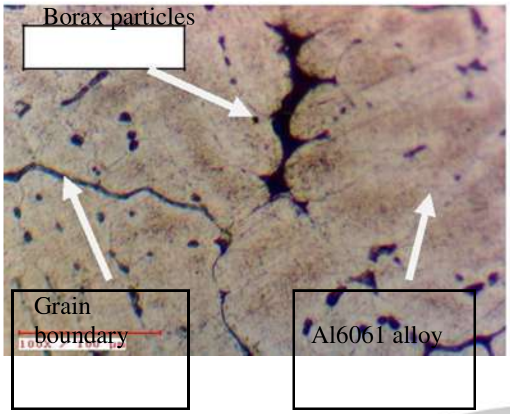


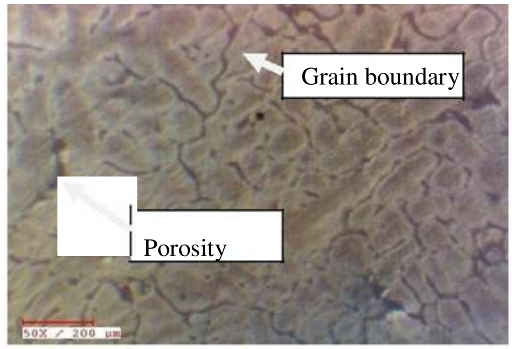


Fig. 5.3 Optical Micrographs of MMC's Composition C 100-200µ (Al+4% Borax)

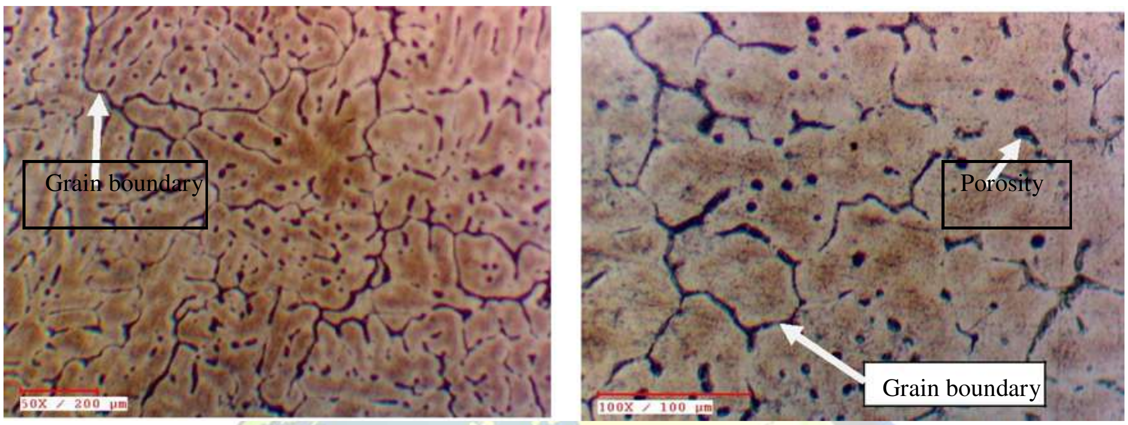
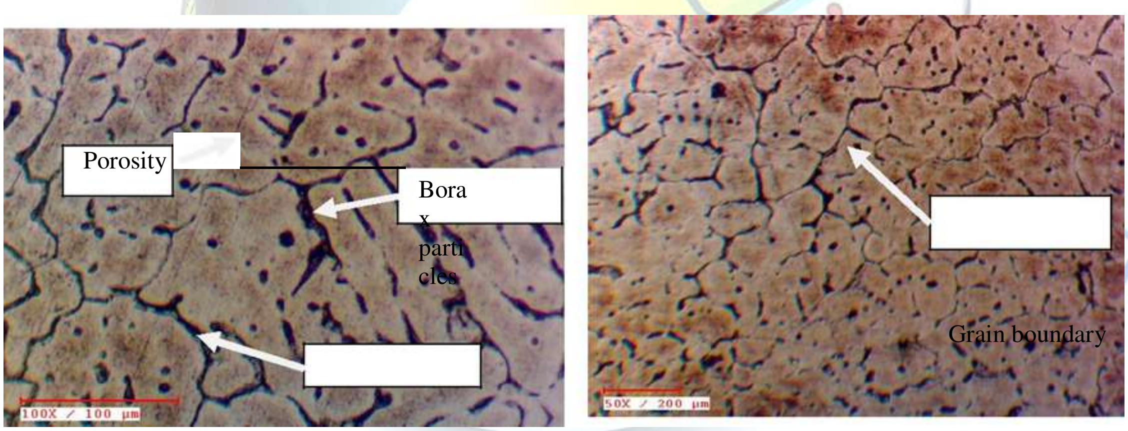


Fig.5.4Optical Micrographs of MMC'sComposition D 100-200µ (Al+6%Borax)



Grain boundary

The Optical Micrographs as shown above fig 5.1, 5.2, 5.3 and 5.4 Compositions A, B, C and D respectively. The optical photomicrographs of the fabricated AMCs are shown in Fig. It is observed from the figure that Borax particulates are dispersed uniformly in the aluminium matrix at all weight percentage. The size of the Borax particles appears to be uniform throughout the aluminium matrix. This can be attributed to the effective stirring action and the use of appropriate process parameters. The metallographic examinations of developed metal matrix composites make it possible to observe the distribution of the reinforcing particles in the matrix phase. Metallographic examinations reveal that the presence of reinforcement particles was observed on the matrix phase as dark spots, the number of dark areas increases in the matrix phases as the addition of particles increases. Reveals the microphotographs of Al6061 reinforced with Br particulates. From figure it is clear that, the distribution of reinforcing particulates in both the composites is fairly uniform in all the compositions studied while increasing the % of reinforcements the grain boundaries arrangement is

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decreases because the mechanical defects are increases

Hardness test

Hardness for MMC's specimens was measured as per ASTM standard by using the specimens and the test was conducted at room temperature. It could be seen from the hardness of the test specimen decreased as the weight percentage of borax reinforcement increased.

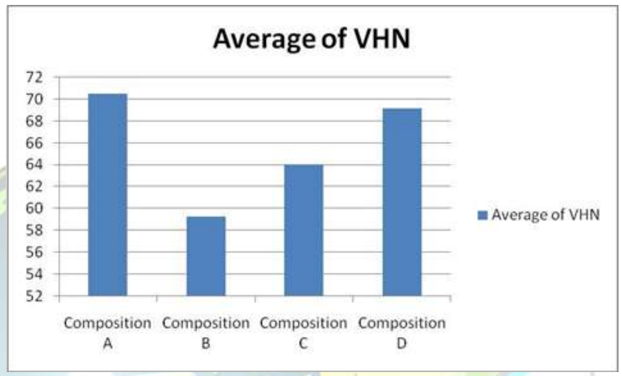

Fig. 6 Graphical representation of hardness comparison

Wear test

Varying load

Wear rate of the composite decreased with increase in hardness of material.

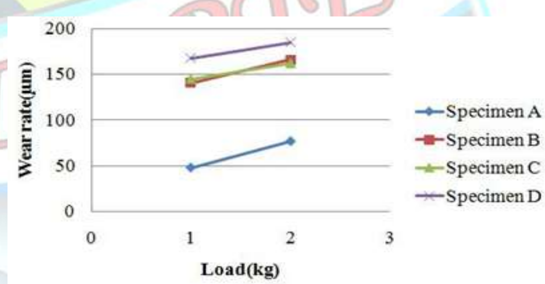

Fig. 7 Comparison of wear rate with load

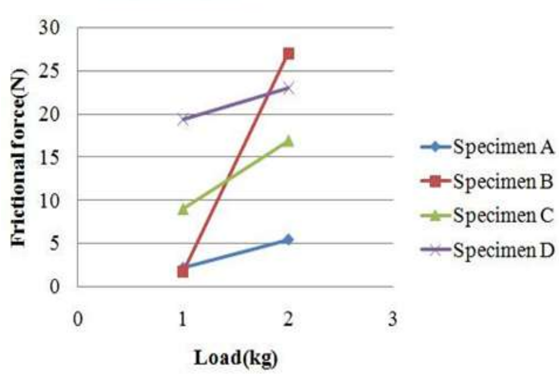

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Fig. 8 Comparison of frictional force with load

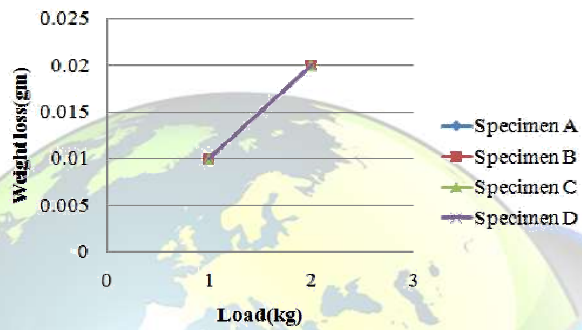

Fig. 9Comparison of weight loss with load

Considering the wear rate of specimen A for 1kg we could see that the wear rate is 48 microns and for 2kg it is 77 microns. Further it is observed that the wear rate has been continuously increasing due to increase in load.

If we could observe the wears rate of the specimen individually like Specimen A, Specimen B Specimen C and Specimen D, the wear rate is increased with increase in addition of particulates with the same percentage.

Varying speed

Wear rate of the composite decreased with increase in hardness of material.

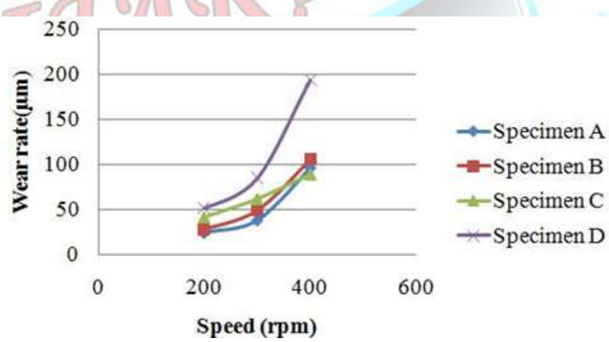

Fig. 10 Comparison of wear rate with speed

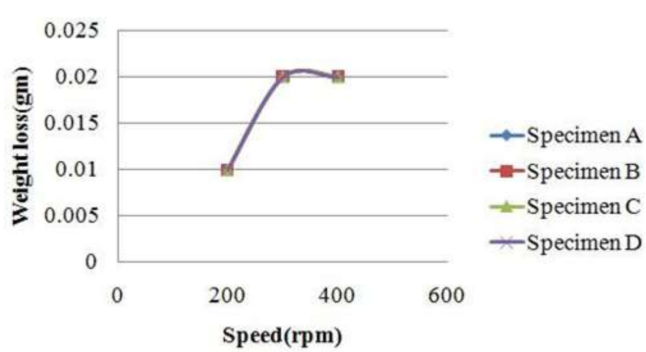

Fig. 11 Comparison of weight loss with speed

Considering the wear rate of specimen A for 200rpm; we could see that the wear rate is 24 microns and for 300rpm it is 38 microns and for 400rpm it is 96 microns. It indicates that the wear rate has been continuously increased with increase in speed.

CONCLUSIONS

In the current study of Al-6061 reinforced with Borax particles metal matrix composites. The following conclusions are drawn from the experimental results.

Wear rate increases with the increase in reinforced particles. It was found that higher speeds the wear rate relatively lesser for any particular load.

With the increase in addition of reinforcement of the particles the hardness is increased because of increasing the percentage of borax.

Here the first addition is increases and next addition is slightly decreases because the base metal also varying by percentages and the increasing the reinforcements are causes the mechanical defects like void, porosity like that so, increasing the percentages of reinforcements results decreasing the mechanical properties.

The micro structural studies reveal that the concentration of both particles in the matrix phase increases with the increase in percentage of reinforcements. In a magnification of 200X, the etched surface of the developed hybrid metal matrix composites shows the clear interface between the matrix and reinforcement.

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